THURSDAY, JUNE 22, 1911.

PROBLEMS OF POTABLE WATER.

Modern Methods of Water Purification. By J. Don and J. Chisholm. Pp. xvi+368. (London: Edward Arnold, 1911.) Price 15*s.* net.

WHEN Mr. Don read his paper on "The Filtration and Purification of Water for Public Supply" before the Institute of Mechanical Engineers in January, 1909, it was generally thought that a very useful addition had been made to the literature on this subject, and in following this up with the volume under review, which is in effect an amplification of the former publication, the authors have done a great service to those whose duty it is to provide a pure and efficient supply of water for domestic purposes.

Following a general introduction, the first chapter deals with the sources of supply. The possible pollutions that may be expected are fully discussed, and some most useful information is given of the best means of detecting, and, as far as may be, preventing them.

Obviously, all water destined for domestic purposes cannot be taken from sources unimpeachable, both as to purity and constancy of supply, and the next two chapters in the book deal with the first steps towards remedying these evils under the general heading of "Storage."

The main inference that is to be drawn from this section is that, in addition to ensuring constant and adequate supply from sources which depend largely on the rainfall over a limited catchment area, storage undoubtedly has a very marked effect in purifying and rendering harmless an otherwise polluted and dangerous water. The work of numerous investigators is quoted in support of this contention, particularly the valuable researches of Dr. Houston on the storage of water from the rivers Thames and Lea, published in his reports as Director of Water Examination to the Metropolitan Water Board.

The result of these researches are very lucidly summed up by the authors in the following sentences:—

"1. The microbes of disease, and those which are indicative of sewage (*B. coli*) perish rapidly in stored water. In about three weeks, generally speaking, the safety change is complete, and the dangers imminent from sewage pollution minimised.

"2. After being impounded for two or three weeks the water is in a better state from a chemical point of view, seeing that there is a well marked decrease of ordinary ammonia, oxygen consumed, oxidised nitrogen, lime salts, and occasionally of albuminoid nitrogen.

"3. Storage deprives the raw water of nearly all its sediment, and therefore serves to prolong the life of the filter beds."

There is one danger, however, occurring sometimes after prolonged storage, which should not be lost sight of; that is the abnormal development in the reservoir of algæ and other minute vegetable growths at certain seasons of the year. These growths not only cause great inconvenience by rapidly choking the filter beds, but certain species give rise to exceedingly unpleasant odours and tastes in the water, which cannot usually be got rid of by filtration. A remedy for these evils, however, is suggested in the book, namely, the addition of exceedingly small doses of copper sulphate, which, it is stated, not only will cause the death of myriads of these organisms, but if added in anticipation of a rapid development will prevent the growth taking place. The use of hypochlorites is also recommended.

Following on this exhaustive and extremely valuable discussion of *storage,* the authors devote a large section to the question of *filtration.* There are three chapters devoted to this subject, entitled respectively, "Sand Filtration." "The Management of Sand Filters," and "Mechanical Filters."

Under the first heading elaborate and exceedingly interesting and instructive explanations are given of the theory of sand filtration, which bring out very conclusively the precautions which are necessary to ensure efficient purification. The action of a sand filter appears to be threefold; first, the mechanical straining of the grosser suspended matter, this causes a film or skin composed of silt, algæ, and bacteria to form on the surface of the sand; secondly, the living algæ in this skin seem to have a power of consuming the bacteria which come within their orbit, thus retaining many of the minute organisms which would otherwise pass through the interstices between the sand grains. The third action is brought about by the slimy or gelatinous film which forms round the grains of sand in the lower layers of the bed; this has the power not only of retaining most of those microbes and minute particles of matter which escape the filmy skin, but also by a process of adsorption, of acting on the organic matter *dissolved* in the water, "mineralising" it, and converting it into innocuous nitrates, sulphates, and carbonic acid.

It is pointed out that to ensure all these actions taking place properly it is necessary that the rate of filtration should be slow (about 4 inches per hour) and uniform, as an irregular flow causes disturbance to the microbes adhering to the slimy coating of the sand grains.

All the operations in connection with the management of filters are dealt with under this heading, and details are given of their construction. Descriptions are given of many of the elaborate processes employed in different parts of the world, and the chapter concludes with a discussion on the use of coagulants for the rapid sedimentation of matter in suspension, and also for the formation of an artificial filtering skin. This leads up to an important chapter on mechanical filters, which are rapidly gaining favour in various parts of the world. Numerous appliances are described, differing chiefly in matters of detail. The general features are the use of a much greater head of water or of artificial pressure, and the use of an artificial skin produced by the addition of alum, and, if necessary, lime or some other alkali, if the water has not sufficient natural alkalinity to precipitate the alumina. The filtering medium employed

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consists of sand or crushed quartz, and in some cases layers of some such oxidising material as polarite or oxidium are used, in addition to sand, as in the Candy filter.

The advantages of this method of filtration seem to be the much more rapid rate at which the water can be passed through the filters, and consequently the much smaller area which they occupy, and the ease and rapidity with which they can be cleaned by mechanical means. This effects a great saving of labour, and also does away with the workmen coming in contact with the filtering medium. As regards efficiency, it would appear that these filters are at least as efficient as ordinary sand filters.

After two very useful chapters on "The Purification of Water by Ozone" and "Water Softening and Household Appliances," two chapters follow on the testing of water. They consist of a discussion of the bacteriological, chemical, and microscopic examination of the raw and filtered waters and the inferences to be drawn from them.

The bacteriological tests suggested, and the methods of applying them are, however, somewhat open to criticism, and need revision in subsequent editions, and the suggestion that these tests should be undertaken by the water managers themselves (unless specially qualified) is also perhaps not of the happiest. To anyone acquainted with the bacteriological and chemical analysis of water, it will be apparent that unless these tests are carried out by skilled operators errors of execution and judgment are likely to crop up. The growing necessity of dealing with impure and polluted sources of supply renders frequent and careful analysis imperative, and the example of the Metropolitan Water Board and some of the Continental and American water undertakers in appointing a staff of qualified analysts might well be followed by other bodies.

As the authors point out, the interpretation of the results of analysis depend largely on local conditions, yet they give a table of the standards of purity required in Britain and America, which, by the way, are not applicable to a very large number of water supplies, and they do not state from what source these standards, in so far as they apply to British supplies, are obtained.

In the remaining chapters, the book deals with problems of distribution, and, in addition to engineering problems, several pages are devoted to the development of such growths as crenothrix in the mains and the action of peaty waters on lead. This latter subject was exhaustively investigated by Dr. Houston about fifteen years ago, on behalf of the Local Government Board, and the authors quote extensively from his work; the two kinds of action, plumbosolvency and erosion, although attributed to different causes, are frequently caused by the same water.

The authors have surely misunderstood Dr. Houston's work when they state (on p. 324) that erosion, which results in the formation of the hydroxide of lead, has probably no consequences obnoxious to the consumer, for they go on to say that the hydroxide scales away and mixes with the current. The section concludes with a general discussion on public health in relation to water supply, and an account is given of several outbreaks of cholera and typhoid fever, which have been attributed to that cause. It should have been pointed out, however, that in the case of the epidemics at Belfast, mentioned on p. 348, the water supply was completely exonerated by the Health Commission appointed to inquire into the matter.

The arrangement of the book is exceedingly good, the type clear, and the numerous diagrams and photographs make the descriptions of the various appliances verv easy to understand. As appendices there are some useful tables of filtration constants and other engineering data, and a concise and well-arranged bibliography of works on water purification.

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GERMAN AND FRENCH BOOKS ON CRYSTALLOGRAPHY.

(1) *Lehrbuch der Kristallphysik (mit Ausschluss der Kristalloptik).* By Prof. W. Voigt. Pp. xxiv+964. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 30 marks.

(2) *Leçons de Cristallographie.* By G. Friedel. Pp. v+310. (Paris: A. Hermann et Fils, 1911.) Price 10 francs.

(3) *Die Kristallgruppen nebst ihren Beziehungen zu den Raumgittern.* By Prof. E. Sommerfeldt. Pp. vii+79 (Dresden: T. Steinkopff, 1911.) Price 3 marks.

(1) THIS treatise is based upon the lectures delivered for some years past by Prof. Voigt at the University of Göttingen, and it concentrates also into a single volume of 964 pages the original work in physical crystallography other than optical contributed in numerous memoirs during the course of a long and active career. Prof. Voigt's name is, perhaps, most familiar from his work on the elasticity of crystals and their piezo- and pyro-electrical properties. These branches of physical crystallography are well represented in the book before us, and the only criticisms that suggest themselves are that Prof. Voigt has not given us more experimental details and illustrations of the interesting forms of apparatus employed in the researches, and that British work in this branch of science, especially the thermal expansion and elasticity of crystals, is not referred to. The result of these omissions is that in the first place the book presents a somewhat forbiddingly mathematical aspect, the theoretical and mathematical side vastly predominating and entirely overshadowing the practical experimental side of the subject, and that in the second place a certain narrowness of outlook is inevitable.

Having said so mucn, however, and remembering that Prof. Voigt's chair is that of theoretical physics, the thorough manner in which the subject is dealt with inside these somewhat narrow lines cannot fail to impress the reader. The most valuable consideration is, moreover, that we have here brought together for us the facts and theories for which hitherto investigators and students have had to search through the numerous original papers of Prof. Voigt. The

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